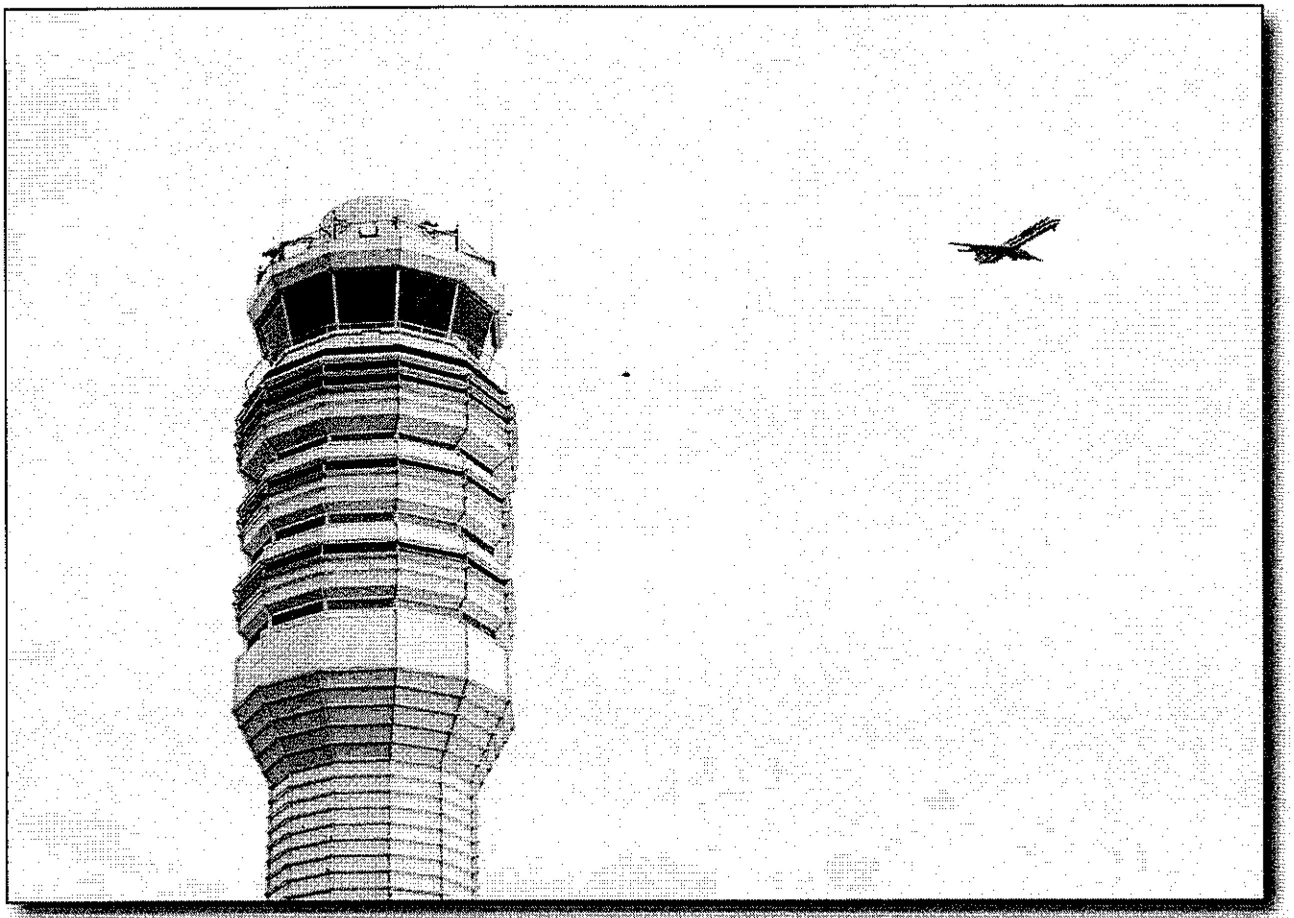


ATC tower

5. Flight Domains

The nation's airspace is divided into flight domains. The airspace or surface area in each domain is controlled by specific types of air traffic controllers. These controllers work in different environments, including ATC towers, TRACON facilities, and ARTCCs. Traffic is controlled on the airport surface in the **Surface domain**, during takeoff and landing in the **Terminal domain**, between destinations in the **En Route domain**, and over water in the **Oceanic domain**. The **Space domain** covers the launch, recovery, and orbit of space vehicles. Each domain presents certain challenges to the responsible air traffic controllers and support personnel. Automation, communication, surveillance, and weather systems designed to meet domain-specific challenges aid controllers in providing required services.

As an aircraft moves between ATC domains, control is carefully managed (i.e., handed off) by controllers during each phase of flight. Before takeoff, the control of an aircraft transfers from the ground controller to the local controller prior to entry on the runway. As the aircraft leaves the runway and enters the Terminal airspace, control is handed off to the radar controller responsible for that Terminal airspace. As the aircraft enters the En Route domain, control transitions to the En Route radar controller. Similarly, control transitions to the Oceanic controller if the aircraft enters Oceanic airspace. During approach and landing, a reverse set of handoffs occurs. Due to the speed of space vehicle launch and recovery, aircraft-type handoffs are not possible, so airspace is cleared for space vehicle operations through the other domains.

The ATC Flight Domains graphic below (Figure 1) summarizes the movement of an aircraft through the flight domains. The color code (● ● ● ●) for each of the domains will be used in the following sections to link the air traffic service capabilities to the domains in which they are provided.

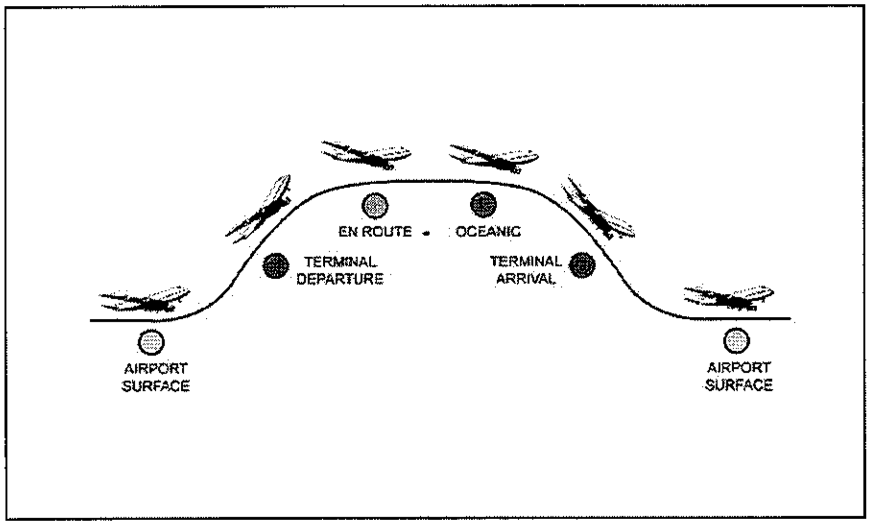


Figure 1: ATC Flight Domains

Surface

Tower controllers manage and control the airspace within about five miles of an airport. They control ground operations on airport taxiways and runways as well as departures and landings. Towers are provided with flight planning information by the En Route center. Weather information is available from airport sensors and also from the NWS via the weather processing and distribution communications network.

Aircraft and many other vehicles share the airport surface. The challenge, especially at the nation's busiest airports, is the efficient movement of this Surface traffic. Personnel who manage the movement of aircraft and other vehicles need accurate and complete information on traffic location and intentions. This is especially important at night and in low-visibility conditions. Decision support automation systems, as well as CNS systems, provide information to support ATC services and help prevent runway incursions.

Airport surface traffic

The FFP1 SMA increases awareness of traffic flow into an airport, giving ramp control operators precise touchdown times. Following FFP1, SMA has been installed at 11 additional sites.

Specialists at the involved ATC facility and air carriers will be able to improve tactical and strategic decisionmaking through the use of SMS. SMS provides accurate predictions of departure demand, queuing, and delays. SMS is being developed as part of the FFP2 priority research effort.

Tower controller at work

Airport Surface Detection Equipment - Model 3 (ASDE-3) is providing improved surface surveillance data at high activity airports. The addition of the Airport Movement Area Safety System (AMASS) provides automated alerts and warnings of potential runway incursions and other hazards to controllers, improving Surface movement safety. Thirty-seven of 38 operational ASDE-3 systems have been commissioned. The system at Ronald Reagan Washington National Airport has not yet been commissioned, as it will be relocated in late 2002. Thirteen AMASS systems have been commissioned.

Airport Surface Detection Equipment - Model X (ASDE-X) will be capable of processing radar, multilateration, and ADS-B data, which will further enhance surface surveillance data. ASDE-X will be installed at 25 airports by 2007. Also, ASDE-X technology will upgrade ASDE-3/AMASS sites with the infrastructure for multilateration and ADS-B. Eight systems are scheduled to be upgraded by 2005.

ADS-B technologies will benefit future Surface surveillance. ASDE-X systems will support ADS-B and the commercial aircraft fleet will equip with ADS-B avionics between 2007 and 2012.

The following chart (Figure 2) summarizes the transition of systems used in the Surface domain over time. Note that the dashed lines are notional timeframes used where schedule information has not yet solidified.

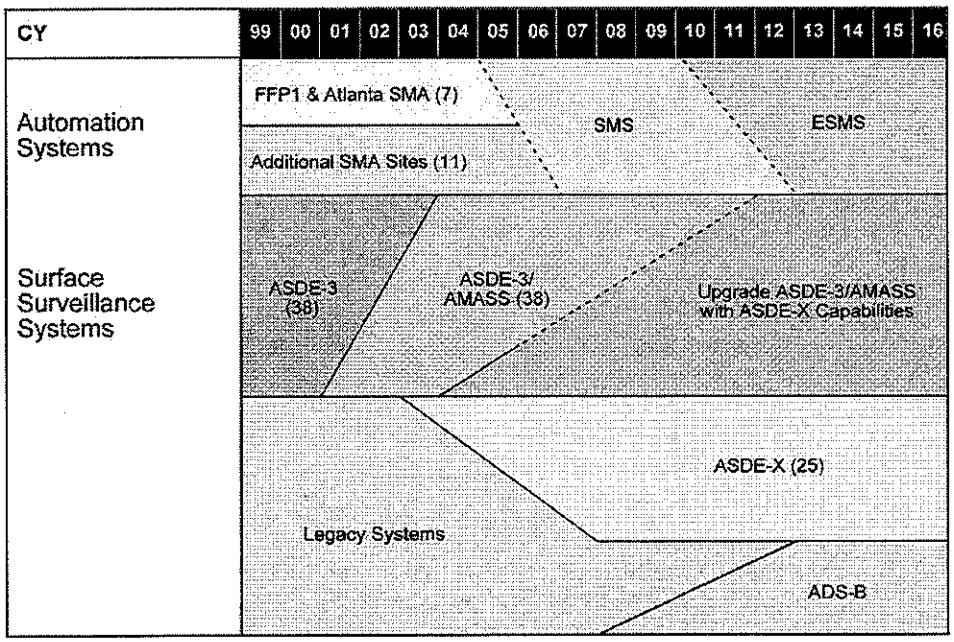


Figure 2: Surface System Transitions

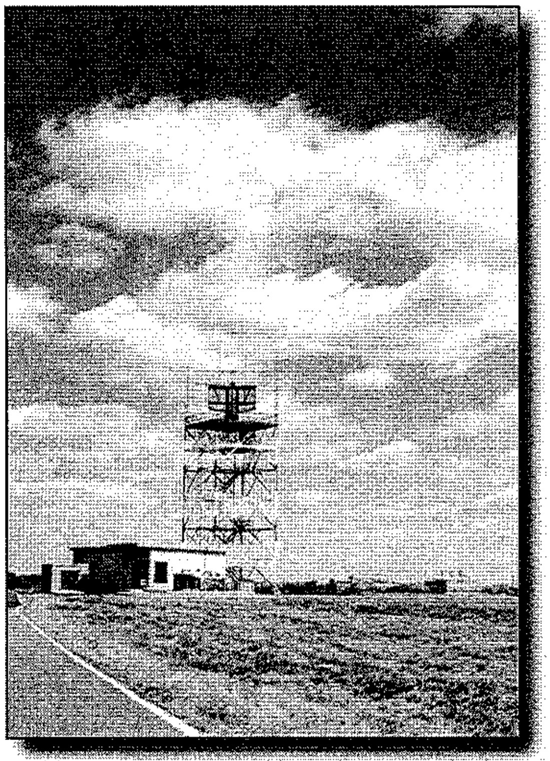
Terminal

Terminal facilities provide ATC services for airspace located within approximately 40 miles of an airport and below 10,000 feet in altitude, although larger TRACONs also control higher altitudes. Terminal controllers establish and maintain the sequence and separation of aircraft taking off, landing, or operating within the Terminal airspace. Terminal facilities are interconnected with local towers and provide surveillance and position data for aircraft under Terminal control to specialized displays within the tower.

Controllers use automation systems, CNS systems, and various types of weather information to coordinate services. New equipment and procedures are being introduced to the Terminal environment to increase capacity and improve safety.

The FAA continues TRACON consolidation activities to address system inefficiencies and realize cost savings resulting from operating and maintaining fewer facilities. One such action nears completion in Northern California. The Bay, Sacramento, Stockton, and Monterey TRACONs will be consolidated into a single facility serving Northern California Metropolitan and outlying areas. The Northern California TRACON began initial operation in August 2002 and is scheduled for full operations in August 2003.

Another consolidation in the Baltimore-Washington region, one of the top four metropolitan areas in air traffic volume, includes five airports: Baltimore-Washington International, Washington Dulles International, Ronald Reagan Washington National, Richmond International, and Andrews Air Force Base. This consolidation will enhance safety and increase traffic efficiency. The region's separate TRACON facilities will be consolidated into a single new facility, the Potomac Consolidated TRACON. The facility is scheduled to be commissioned late in 2002.



ASR-9

Additional consolidation efforts are planned, or are in progress, in Chicago, Atlanta, the Florida Sun Coast, and Central California regions.

Modern STARS equipment will replace aging ARTS equipment and aid Terminal controllers in providing separation assurance. STARS Early Display Configurations are operational at El Paso and Syracuse TRACONs.

The Airport Surveillance Radar - Model 9 (ASR-9) and Mode Select (Mode S) radars were expected to remain operational until 2005 and 2008, respectively. However, the existing infrastructure must be maintained until the transition can be made to space- or aircraft-based surveillance, utilizing GPS, Wide Area Augmentation System (WAAS), Local Area Augmentation System (LAAS), and ADS-B technologies. A Service Life Extension Program (SLEP) is planned to eliminate obsolescent parts and significantly improve the reliability and maintainability of these systems. This will result in lower maintenance costs, improved reliability, and better overall service.

ASR - Model 11 (ASR-11) will improve system efficiency and availability of service in the NAS by replacing existing ASR - Model 7/8 (ASR-7/8) systems and associated Air Traffic Control Beacon Interrogator - Model 4/5 (ATCBI-4/5) equipment. The FAA plans to commission the ASR-11 at 112 airports by 2009.

The NAS ground infrastructure to provide ADS-B air-to-ground surveillance services and ground-to-air uplink broadcast services will be deployed from 2007 to 2012. ADS-B surveillance data (i.e., call sign, position, airspeed, intent, etc.) will provide improved ATC surveillance for controllers. Air carrier fleets will achieve the intended initial ADS-B benefits in the Terminal airspace after 2012.

Terminal weather system improvements include the ASR-9 Weather Systems Processor (WSP), Integrated Terminal Weather System (ITWS), and Medium Intensity Airport Weather System (MIAWS). WSP will be commissioned at 34 ASR-9 sites by 2003. The system will improve safety by warning controllers and pilots of hazardous wind shear and microburst events near runways. ITWS installations at 34 TRACONs, serving 47 of the busiest airports, began in 2002 and will characterize the current Terminal weather situation and include a forecast of anticipated weather conditions for the next 20 minutes. MIAWS will provide a real-time display of storm positions and estimated storm track products using Next Generation Weather Radar (NEXRAD) data at Low-Level Wind Shear Alert System - Relocation/Sustainment (LLWAS-RS) sites. Thus, MIAWS will address weather information deficiencies at airports with too few flight operations to warrant a Doppler weather radar system. Tentative plans are to install MIAWS at 40 airports by 2004.

Figure 3 summarizes the transition of systems used in the Terminal domain over time. Note that the dashed lines are notional timeframes used where schedule information has not yet solidified.

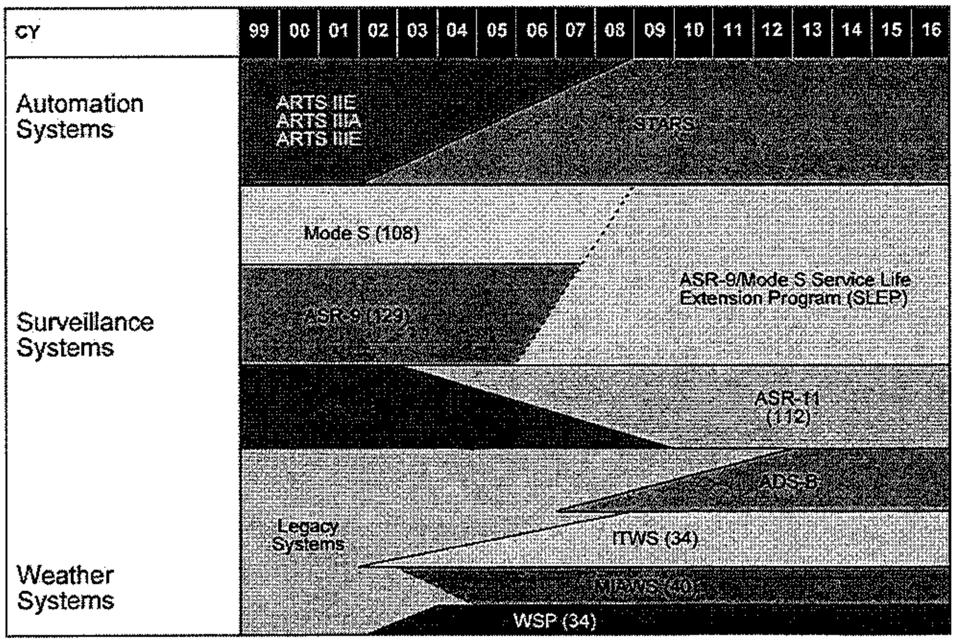


Figure 3: Terminal System Transitions

En Route

Twenty En Route centers control domestic airspace not specifically delegated to an Oceanic, Terminal, or tower control facility. Domestic airspace extends to 100 miles beyond the U.S. coast and borders with Canada and Mexico. En Route centers operate the computer suite that processes radar surveillance and flight planning data, reformats it for presentation purposes, and sends it to the Display System Replacement (DSR) equipment used by controllers to track aircraft. En Route centers control the switching of voice communications between aircraft and the center as well as between the center and other NAS facilities. En Route centers are also interconnected to the Traffic Flow Management (TFM) systems at the ATCSCC. Weather data also are processed and distributed by the En Route centers.

Many technological advances have been made in the En Route environment, several due to Free Flight initiatives that provide new automation tools in support of Free Flight concepts. Improved weather data processing and display systems provide enhanced weather data to controllers, traffic managers, and automation systems.

ARTCC automation system improvements include completion of all Host and Oceanic Computer System Replacement (HOCSR) installations at 20 ATC centers and in New York, Oakland, and Honolulu in 1999. DSR installations were completed in 2000. The En Route Automation Modernization (ERAM) program has been initiated to continue the modernization of the ARTCC automation software. ERAM will replace Host Computer Systems (HCS) and will address information security requirements. The ERAM contract award is planned for March 2003. The system will be installed in all ARTCCs by 2008.

FFP1 introduced CDM, URET, and TMA-SC. CDM provides AOCs and the FAA with real-time access to NAS status information, including weather, equipment status, and delays. FFP1 CDM was completed in 2001. FFP2 will add functionality to CDM. URET allows controllers to manage pilot requests in the En Route domain more efficiently. URET is currently operational in six ARTCCs and will be expanded in FFP2 to all ARTCCs by 2004. The TMA-SC is another FFP1 accomplishment in the En Route environment. Significant fuel savings and reduced passenger delays result from using TMA-SC. FFP1 installed TMA-SC in seven locations, while FFP2 will expand the tool to four additional sites.

> "When the industry came to us three years ago, they laid the challenge of Free Flight at our doorstep . . . we've met that challenge. URET technology works for the controller, the pilot, and the passenger."
>
> Jane F. Garvey,
> *former* Administrator
> Federal Aviation Administration

En Route surveillance has improved through installation and acceptance of 43 operational Air Route Surveillance Radar - Model 4 (ARSR-4) systems completed in May 2000.

The ATCBI - Model 6 (ATCBI-6) will replace aging ATCBI equipment (Models 4 and 5) at 124 operational sites to maintain surveillance and decrease supportability costs. Commissioning is scheduled to be complete in 2006.

The NAS ground infrastructure will be deployed from 2007 to 2012 to provide ADS-B air-to-ground surveillance services and ground-to-air uplink broadcast services. ADS-B surveillance data (i.e., call sign, position, velocity, intent, etc.) will provide improved ATC surveillance for controllers. Air carrier fleets will achieve the intended initial ADS-B benefits in the En Route airspace after 2012.

The U.S. government has determined that two additional signals are essential for certain uses of GPS. The GPS modernization program includes the addition of new L2 and L5 frequency civil signals. Additionally, an entirely new constellation of Block III GPS satellites are to be procured. These satellites will offer higher power military and civil signals, more accurate service for all users, and increased integrity.

A 21-day WAAS test was completed in 2001. Measured accuracy was 1.0 meter horizontally and 3.0 meters vertically, well within the 7.6 meter requirement. WAAS improves the accuracy and availability of GPS signals, offering a new means of navigation in the NAS. WAAS Initial Operational Capability (IOC) for safety applications is expected in 2003.

En Route weather technology advances include phased improvements to the Weather And Radar Processor (WARP) systems at all ARTCCs and the ATCSCC. These improvements include the display of mosaics from upgraded NEXRAD weather radar systems integrated with surveillance data on DSR and enhanced weather products to traffic managers and automation systems.

Figure 4 summarizes the transition of systems used in the En Route domain over time. Note that the dashed lines are notional timeframes used where schedule information has not yet solidified.

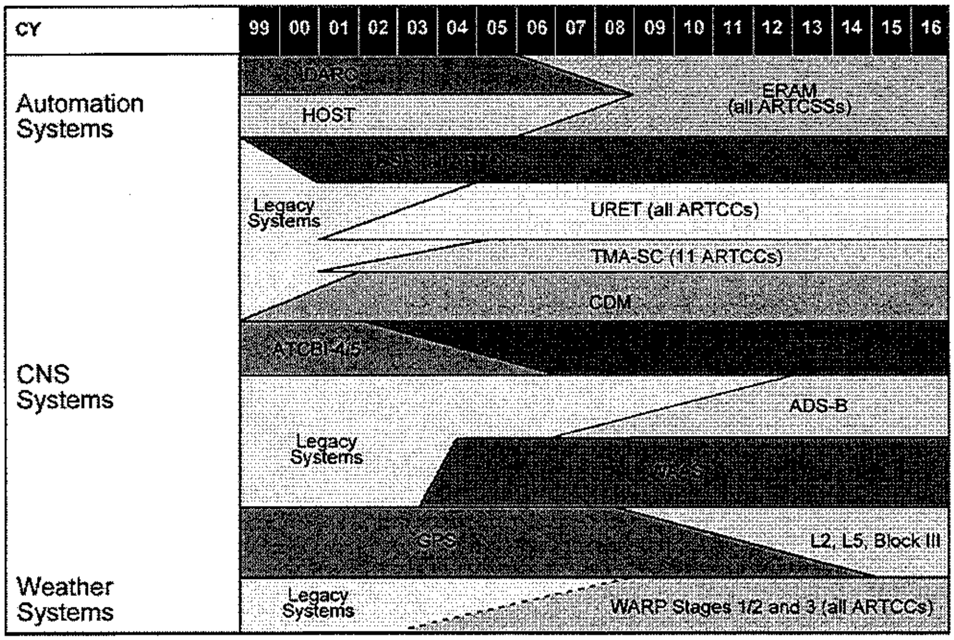


Figure 4: En Route System Transitions

Oceanic

The FAA has been allocated 80 percent of the world's controlled Oceanic airspace by the ICAO. The FAA provides ATC services for Oceanic flights within an area of approximately 3 million square miles in the Atlantic Ocean and 18 million square miles in the Pacific.

The Oceanic ATC centers control aircraft over portions of the Atlantic, Arctic, and Pacific oceans. Two Oceanic centers are co-located with En Route centers in New York and Oakland; a third is located in Anchorage. Oceanic ATC is substantially different from ATC provided over land because there are no surveillance systems to provide exact aircraft position. Position reports based on onboard aircraft navigational systems are radioed to the controller. Due to the uncertainty in position report reliability, planned overseas flight tracks must provide greater separation margins to ensure safe flight. As a result, Oceanic air traffic is rarely able to obtain maximum fuel efficiency, minimum travel times, or access to preferred flight paths.

Oceanic airspace capacity has been increased through the reduction of vertical separation standards. The Reduced Vertical Separation Minima (RVSM) concept was introduced over the North Atlantic in 1997. RVSM has been implemented on routes over the Pacific Ocean.

Advanced Technology and Oceanic Procedures (ATOP) will provide the Oceanic and offshore air traffic communities with modern automation equipment and internationally compatible ATM services. ATOP will replace the Oceanic systems in Oakland, New York, and Anchorage. The ATOP contract was awarded in June 2001. The systems are scheduled to be operational by April 2004.

Figure 5 summarizes the transition of systems used in the Oceanic domain over time.

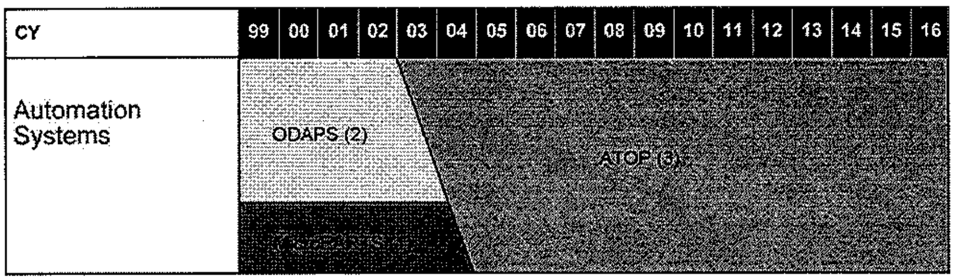


Figure 5: Oceanic System Transitions